Navigating the Numbers of Climatological Impacts

Human activity is guided, if not forged by, the various climates in which we live. Whether it is our clothing, shelter, diet, or recreation, the annual seasons as well as the longer-term variations play a significant role in determining our resources and comfort level. Yet despite our intimate relationship with the surrounding environment, surprisingly little effort has been made to quantitatively inventory the global or regional-level impacts (losses and gains) associated with climate variability. After years of examining the physical processes of climate, the research community has amassed large data sets of temperature, precipitation, pressure, etc., yet few series exist which provide the same global perspective for the numerous impacts associated with climatological events. Nearly innumerable case studies and assessments do exist, but often these studies are more concerned with the mechanisms and causes of impact, therefore the "what" and "how much" are simply snap-shots in time of a particular event and region. Because most impact research is rooted in case studies, our understanding of how climate affects society is, and has become, an amalgamation of anecdotes rather than a practice of accounting. In addition most efforts to document climatological impacts typically examine disaster-related losses thereby failing to capture the higher order effects on development, biota, and other items that do not hold a market value. A complete inventory is very far from being assembled.

What is the utility of a good record?

History.........a great portion of research in the geosciences is in someway directed at understanding the past in order to determine the future. Not surprisingly the first principles and lessons in this field emerged from historical studies and debates. The founding concept of Uniformitarianism (proposed by James Hutton, a Scottish geologist) is simply the idea that physical processes of the earth are constant and repetitive. Although Uniformitarianism was originally applied to understand the rock strata and age of the earth, the meteorological sciences have applied much the same principle.

During the earlier part of this century (including both World Wars), American meteorologists attempted "weather typing" as a means to forecast.[1] In doing so a catalog of atmospheric conditions was kept and then used as a database to match with current conditions. The belief was that previous patterns could be used to roughly gauge how things might further develop. Unfortunately the database was too cumbersome to practically wield, moreover as a predictive tool it was based on the "rhetorically plausible yet theoretically unsound forecasting strategy."[2]

Great advances since then in modeling, observations, as well as the advent of computers, have improved and made available various forecasts of weather and seasonal conditions. However, knowing the physical history and being able to project

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[1] Monmonier, Mark, Air Apparent: How Meteorologists Learned to Map, Predict, and Dramatize Weather, University of Chicago Press, Chicago, c1999.

[2] *ibid. page 239*

upon that does not particularly illuminate how society will interact with, or will necessarily be affected by, climatological events. Impacts are the "fingerprints" of a climate-human dialogue.

A narrative of climatological impacts, whether formally archived or held in the collective memory of the population, is in essence a historical perspective that chronicles the interaction between climate and society. By understanding and remembering what has occurred, it is possible to speculate about the future and gain an insight that becomes the foundation of adjustment strategies. Such a historical foundation enables society to anticipate losses and gains, direct policy, and raise public awareness in the hopes of promoting responsibility and preparation.

Using our climatological history as a means to cope with the possible futures of climate change and variability was first formalized by Glantz as "Forecasting By Analogy." With FBA the responses to previous climatological events are used to describe likely future responses to, as well as accruing impacts from, climate extremes.

> *"[I]n order to know how well society might prepare itself for a future change in climate (the characteristics of which we do not yet know), we must identify how well society today can cope with climate variability and its societal and environmental impacts. [W]hile the climate of the future may not be like the climate of the present, societal responses to climate change in the near future will most likely be like those of the recent past and the present."*[3]

As a caveat there is, or should be made, a distinction between discussing how climate previously had an impact and then actually appraising the risk of a particular hazard to society or environment. Impact estimates serve to remind where precedence for either loss or gain does exist, however assessing risk actually involves understanding the interaction between humans and climate. Impacts are the by-product of this interaction, and should not be confused with a mechanical description of the climate-human interface or a projection of likely impacts.

But aside from developing a historical perspective with which to judge the future, a reliable database of climatological impacts can also help to evaluate the cost-benefit and effectiveness of present polices and practices.[4]

> *"Poor knowledge of the resulting economic losses hinders implementation of effective disaster mitigation policies and emergency response programs. Better loss estimates would benefit federal, state, and local governments, insurers, scientists and researchers, and private citizens (both as taxpayers and insurance purchasers)."*[5]

[3] Glantz, M. ed., Societal Responses to Regional Climatic Change: Forecasting by Analogy, p1.
[4] Kramer, R., *Advantages and Limitations of Benefit-Cost Analysis for Evaluating Investments in Natural Disaster Mitigation*, Disaster Prevention For Sustainable Development: Economic and Policy Issues, Ed. Munasinghe, M., Clarke, C., IDNDR, World Bank, c1995.
[5] National Research Council, The Impacts of Natural Disasters: A Framework for Loss Estimation, National Academy Press, Washington, D.C., c1999, p45.

Within the United States alone, half a dozen federal agencies, in addition to FEMA, respond to disasters through one method or another. If their objectives are to ensure that life as well as property is not lost, then standardized records will be needed to detect improvement or note the failure of policies and legislation. Given that economic costs associated with most natural disasters have increased substantially over the past several decades (both within the U.S. and globally)[6], the need for governments and the private sector to reduce their exposure and losses is equally increasing.

The use of impact records in policy management also includes the decision to use, or not use, climate information (forecasts, observations, climatologies, etc.). A good understanding of the typical impacts accruing from climate variability can help proxy the role that climate information, such as forecasts, might play in the actions taken by particular sectors or governments. In the end, however, climate information and research is only as valuable as it is successfully disseminated and applied to reduce adverse impacts or capitalize upon opportunities.[7]

Finally, impact records are also a practical and necessary means with which to raise public awareness. Since the onset of the 1997-98 El Niño, the media has often referenced studies on the global costs incurred from climate variability. Articles in refereed journals have also taken to using these impact estimates as a way to highlight the social relevance of scientific research.

Of course impact estimates have not been limited solely to El Niño, either. Over the past several years, insurance companies as well as humanitarian aid and development groups have also published calendar-year estimates of loss incurred by all natural disasters. Not surprisingly, the media and some researchers anxiously await these annual tallies.

Although impact records may sometimes help fuel exaggerations, or even result in misunderstandings, these estimates likely do far more to educate than cause rumors, if used to raise awareness about cost. Sometimes this educative labor is expressed through serious public awareness projects, media reports, lighthearted cartoons, or happen to coincide with marketing attempts, but either way it makes climate, and features of climate, part of the vernacular.

> *"People know, when they hear the words El Niño, that something is happening somewhere in the Pacific Ocean. However, they may not know exactly what that something is. They may also believe that it has an effect on their weather, but they may not know with any degree of exactness what that effect is."*[8]

[6] Mileti, D., Disasters by Design: A Reassessment of Natural Hazards in the United States, Joseph Henry Press, Washington, D.C., c1999.
[7] National Research Council, Making Climate Forecasts Matter, Stern, P., Easterling, W., editors, National Academy Press, Washington, D.C., c1999.
[8] Glantz, M., Currents of Change: El Niño's Impact on Climate and Society, Cambridge University Press, c1996, p141.

Individuals generally become aware of climate and weather through personal experience or the accounts of others as found in sources such as the media. Since extreme events are infrequent at the local level, climatological impacts, and their reporting, are a valuable means of dispersing societal experiences.[9]

Why climatological impacts?

The discussion of this report is rooted in climatological impacts, however it would be surprising if the estimates from other natural events, such as earthquakes, volcanoes, tsunamis, etc., did not suffer from many of the same uncertainty and standardization issues. There is probably significant overlap and applicability.

At the same time, climatological events perhaps encompass the "lion's share" of impacts in comparison to geophysical events such as earthquakes and volcanoes. The later may be more fearsome on an event-by-event basis, but in total climatological impacts are more prevalent. Burton et al[10] have noted that, "Approximately 90 percent of the world's natural disasters causing more than 100 deaths originate in four hazard types: floods (40%), tropical cyclones (20%), earthquakes (15%), and drought (15%)" Of the costs associated with natural hazards and disasters occurring in the United States from 1975 to 1994, 80 percent have been estimated as climatological.[11] Examination of international humanitarian aid *responses* as well as *recognized* major disasters also illustrates the comparative importance of climatological events. (see Figure A)

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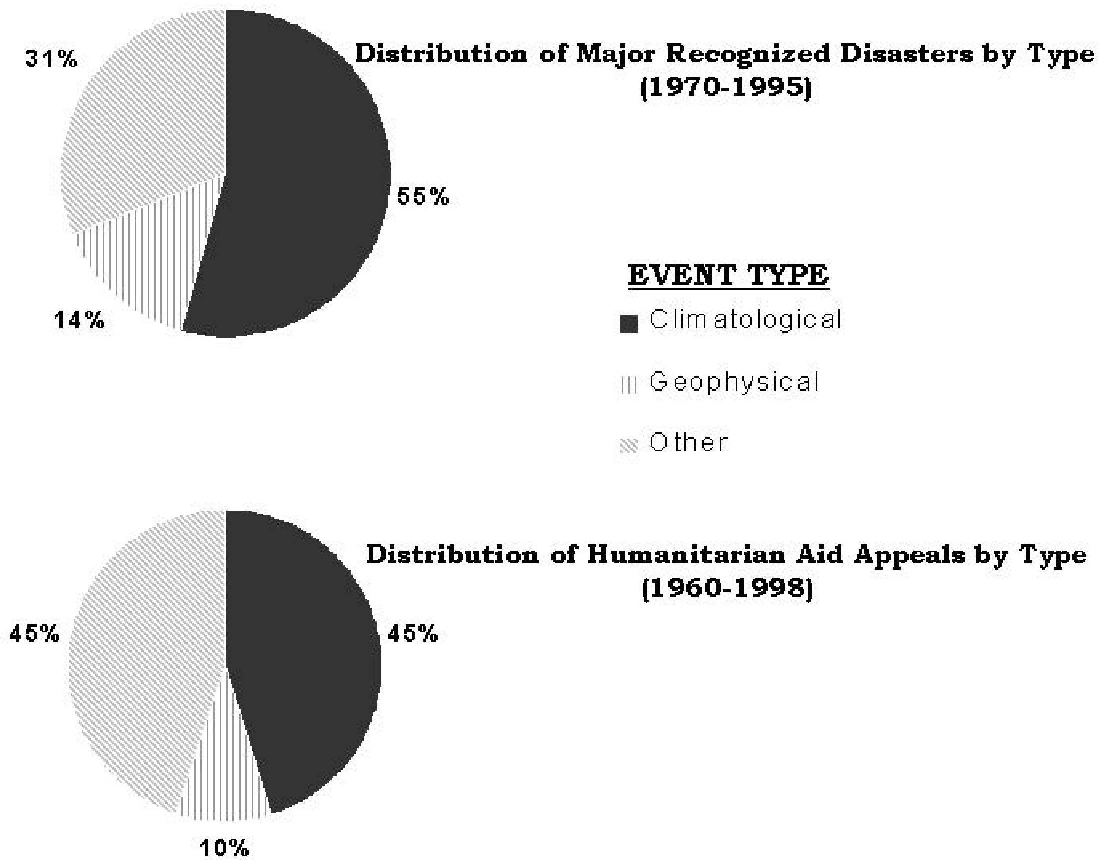
[9] Ungar, S., "Is Strange Weather in the Air? A Study of U.S. National Network News Coverage of Extreme Weather Events", *Climatic Change*, Kluwer Academic Publishers, 41:133-150, c1999

[10] Burton, I., Kates, R., White, G., The Environment as Hazard, 2nd edition, The Guilford Press, NY, c1993, p10.

[11] Mileti, D.S., Disasters by Design: A Reassessment of Natural Hazards in the United States, Joseph Henry Press, Washington, D.C. c1999.

FIGURE A: A Global Examination of the Relative Impact of Climatological Events



* The above images were produced by the NOAA Office of Global Programs Rapid Response Project. The top chart was created with data adapted from the USAID/OFDA (U.S. Agency for International Development, Office of U.S. Foreign Disaster Assistance): 1996, *Disaster History*, USAID/OFDA, Washington, DC. The bottom image was produced from adapted records of the International Federation of the Red Cross (IFRC) appeals for humanitarian assistance.

Climatological events were defined as precipitation or temperature induced events. This included brush and forest fires. Because other circumstances often play a crucial role in the development of epidemics and famines, these were categorized as "other" rather than climatological events. Geophysical events refers to volcanic or seismic hazards. The "other" category included civil strife, refugees, etc.

Finally, climate is an important factor, among many, which directs human progress. In fact a "large body of technology constitutes a deliberate response to climate, though this fact is taken so much for granted that it is usually forgotten. [For instance, a]griculture as a whole is an effort to harvest atmospheric and solar resources."[12] Unlike many other hazards, climate variability, and its influence upon society, does not occur through a few annual, devastating events, rather climate directs society through a series daily interactions that are both beneficial and harmful.

Needs

Despite the substantial effect of climate on society, unfortunately little attention has been paid to the biases and range of impact estimates associated with these climate events. So varied were the global loss estimates attributable to the 1997-98 El Niño that they spanned from 14 billion to 69 billion US dollars. This variation is not so much a result of error as it is a myriad of different data sources and collection methods.

The precision of impact estimates, however, is of lesser concern than the tendency to simply describe impacts through a few global totals. By aggregating impacts into a single estimate, much of the knowledge and insight into the human-climate interface is lost. In short, the environment does not affect us in simple, one-number packages.

The following sections highlight the weaknesses found among most impact estimates, thereby suggesting areas for improvement as well as noting caveats for potential users of impact information.

a. A Baseline

One of the greatest needs for research on climatological impacts is a baseline or record of "typical" losses and gains – defined both spatially and in time. Many trends and graphs do exist, but when viewed with the current caveats and uncertainties, these must inevitably be relegated as guides and proxies. Only recently have we begun to quantitatively uncover the varied losses and benefits (impacts) associated with climate variability, and these estimates have yet to be referenced to a "normal" year.[13]

This report would argue that without a good inventory of the typical losses and gains caused by climate variability, it is more difficult to surmise about trends as well as evaluate and analyze the interaction between climate and society. Anecdotal references are quite useful in identifying and prioritizing possible threats and opportunities, however knowing what problems might arise and daring to actually manage a situation are separate tasks demanding data of differing resolutions.

b. Standardization of Data

As a general rule the standardization of data collection and the reporting of natural disasters is nearly non-existent[14], and of the few data series around, most have not

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[12] Hare, F.K., Sewell, W.R.D., *Awareness of Climate*, Geography, Resources, and Environment, Vol. II, Themes from the Work of Gilbert F. White, Ed. Kates, R., Burton, I., The University of Chicago Press, Chicago, c1986, p209.

[13] Glantz, M., *Climate Change*, "Render Unto Weather", VOL1, 1978, p305-306.

[14] Kunkel, K., Pielke Jr., R., Changon, S., "Temporal Fluctuations in Weather and Climate Extremes that Cause Economic and Human Health Impacts: A Review", *Bulletin of the American Meteorological Society*, Vol. 80, No. 6, June 1999.

been operational for many years. Even the lengthier data sets are plagued by abrupt changes in the sources used, and inherently these various references report damages and benefits with fickle resolution.

Table A is a conglomeration of estimates describing losses incurred from El Niño, climate variability, and natural disasters in general. Admittedly the numbers listed in the table cover different events and periods under examination, nonetheless the comparison of the magnitudes are astonishingly diverse. As mentioned before the range of estimates describing the losses attributable to the 1997-98 El Niño was quite large.

TABLE A: A Range of Costs
An Illustration of Various Methodologies

COST OF ALL NATURAL DISASTERS:			
Global:	1998	$92 billion	World Resources Institute
	1998	$90 billion	Munich Reinsurance
	1997	$30 billion	Munich Reinsurance
	1996	$60 billion	Munich Reinsurance
U.S. Annual Average from 5 Year Sample-			
		$54 billion	US National Science and Technology Council
COST OF CLIMATE-WEATHER RELATED DISASTERS:			
Global Annual Average from 10 Year Sample (1987-1996)-			
		$47 billion	Center for Research on the Epidemiology of Disasters (CRED), 1998 International Federation of the Red Cross World Disasters Report
US Annual Mean-			
		>$15.8 billion	*Kunkel et al., 1998*
GLOBAL COST OF THE 1997-98 EL NIÑO:			
		$14 billion	World Meteorological Organization
		$25 billion	National Oceanic and Atmospheric Administration's Office of Global Programs *(U.S. federally recognized foreign disasters related to El Niño.)*
		$36.6 billion	National Oceanic and Atmospheric Administration's Office of Global Programs *(excluding China floods of 1998)*
		$69 billion	National Oceanic and Atmospheric Administration's Office of Global Programs *(including China floods of 1998*)
GLOBAL COST OF THE 1982-83 EL NIÑO:			
		$13.5 billion	National Oceanic and Atmospheric Administration
ANNUAL AVERAGE COST OF HURRICANES IN US			
		$4.8 billion	Pielke and Landsea, 1998 (1995 dollars)
COST OF THE 1988 DROUGHT IN US:			
		$39 billion	Riebsame et al., 1991
COST OF HURRICANE ANDREW:			

	$30 billion	Pielke, 1995
US ANNUAL MEAN COST OF TORNADOES		
	$2.9 billion	Kunkel et al., 1998

Even more perplexing is that the costs associated with the 1982-83 El Niño are quoted at $13 billion, yet figures produced for all weather-related losses for the entire calendar years of 1982 and 1983 claim only a combined value of $8.3 billion.

The El Niño Southern Oscillation aside, estimates for annual losses attributable to all natural catastrophes, range from $30 billion to $90 billion. To make matters even more confusing, it has been estimated that annual losses from natural disaster cost the U.S. upwards of $54 billion a year, yet this total is as much, if not greater than, some global losses. The costs associated with single events also surpass or equal many global tallies.

None of the estimates are wrong or more rigorously assembled than others, rather the discrepancies result from varying sources of information, methodologies, as well as external factors that either cause impacts to be over- or underestimated.

c. Human Perception of Impact

The way impacts are recorded is largely a function of perception and scale. What is devastating to an individual is not likely to register on an international level, except in the most extreme calamities. The incentives, disincentives, and cultural preferences of an affected area often guide this perception of impact, which in turn influences the reporting and visibility of impacts and interactions.

Different economies will inevitably have varying sensitivities to the losses and gains associated with climatic fluctuations and these preferences and practices either increase or decrease impact estimates. For instance it is likely that incentives, such as relief-aid, government aid, and insurance, have increased the number of reported events over time. Increased physical observing systems (e.g.- Doppler Radar) as well as the advent of the Internet have also likely improved reporting through better event verification and data sharing. Certain incentives and improvements such as these often enlarge our awareness of climate variability and therefore result in the "social amplification"[15, 16] of impacts. The insurance industry, as well as the media, has almost certainly played an integral role in increasing, as well as improving, impact records.

It should be noted that amplification does not necessarily coincide with deliberate or accidental inflation of impact estimates. Although falsification does often occur, as one regional governor from Honduras did after Mitch, social amplification is more often a

[15] Hohenemser, C., Kates, R.W., and Slovic, P. 1983. The Nature of Technological Hazards, Science, 220, 378-384.
[16] Kasperson et al, The Social Amplification of Risk: A Conceptual Framework, Environmental Risks and Hazards, Ed. Susan Cutter, Prentice Hall, c1994.

result of a heightened awareness of climatological impacts. On an international scale, social amplification often reflects a newfound willingness or ability to record climatological losses and gains, rather than an intention to deceive.

A potentially more serious and chronic problem in impact estimates, particularly in rural or impoverished regions, however, is the "social devaluation"[17] of losses and gains. For many reasons, including the absence of societal support (a working government, attentive media, etc.) or the comparative negligibility of losses relative to other pressing needs, many individuals and governing bodies fail to report impacts or describe their interaction with climate variability. As a result some groups, and their interaction with the surrounding environment, are not captured by existing estimates. In practice most devaluation occurs among the poor or uneducated populations. On a global scale most impact reports of the developing or underdeveloped economies also tend to be grossly underestimated.[18] Unfortunately these populations tend to be the most adversely affected by climatic fluctuation. In part the tendency to underestimate damages or gains from climate variability results from a limited vocabulary with which to describe, or simply the inability to measure, most types of impact which are either indirect or do not hold a global market value.

In addition the social devaluation of climate impacts may not necessarily reside within the habits of a particular population, but rather result from an imposed outside perception of importance. For instance the records of relief-aid and insurance groups dominate our awareness of impacts as well as the populations we observe, therefore data series of impact which rely upon these sources are almost inherently underestimating the losses associated with climatological impact. Our awareness of impacts is narrowed by a limited reporting mechanism.

d. New Estimators for Different Climates, Different People, and Different Impacts

The distinction between flood, drought, fog or another climatological event can be enough to differentiate the type of impact incurred, but of equal importance to such considerations are the traits of the population and region where an event occurs. When human systems are examined, with particular reference to natural disasters, it becomes readily clear how important infrastructure, organization, and assets are as means to cope with climatological events.[19] Environmental factors, such as climate, interact with pre-existing economic, political, and social conditions. In turn this often exacerbates the current vulnerabilities or perhaps even provides new opportunities. For instance, Indonesia faced multiple challenges during the 1997/98 El Niño: the Asian economic crisis, the replacement of a political regime that ruled for 32 years, and severe environmental problems such as drought and forest fires.

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[17] The author purposefully uses the term "devalue" as it emphasizes societal stigmas and habitats that internalize or ignore all or specific losses and gains of climatological impact.

[18] Burton I., R.W. Kates and G.F. White, *The Environment as Hazard*, 2nd edition, The Guilford Press, New York, 1993.

[19] Homer-Dixon, T., Environment, Scarcity, and Violence, Princeton University Press, c1999.

Since an impact (gain or loss) is dependent upon numerous physical and social factors, it is odd that only a hand-full of indicators are typically referenced to describe very different situations and likely outcomes. Because the interaction of humans and climate is a "tailored" experience with each event, the estimators commonly used have biases to specific regions and populations. It could even be said that because these proxies are so few (typically dollars, deaths, and injured persons) and rarely standardized between datasets, such information is not enough to describe the interaction of humans with climatological events. At best these two or three proxies can only identify that we are indeed significantly affected by climatic fluctuation.

Moreover, because estimators have become the shorthand to document the climate-human interface, we have in a very real sense limited the vocabulary with which we describe different scenarios and impacts. This misplaced emphasis on only a few variables has likely distracted us from tallying the numerous other costs associated with climate fluctuation. How we are impacted by climate variability is as diversified as the people affected by it, so it only makes sense to have a host of indicators to evaluate and describe human and climate interaction. As Hewitt[20] observes, "Most natural disasters, or most damages in them, are *characteristic* rather than accidental features of the places and societies where they occur."

This does not mean current measurements are useless, rather we simply need different ways of comparing impact, particularly on an interregional level.

e. Counting Unseen Costs

Governments and international organizations have traditionally been concerned with market damages, although many are now realizing the importance of non-market indicators to describe longer-term trends and perform cost-benefit analysis.[21] In fact there is little doubt that the higher-order and indirect impacts caused by natural disasters are much greater and longer lasting than estimates frequently quoted. [22]

> *"Natural disasters destroy decades of human effort and investments, thereby placing new demands on society for reconstruction and rehabilitation. This halts and, in some cases, reverses economic progress. Large-scale natural disasters can have profound, negative impacts on long-term development, causing distress and increasing dependency."*[23]

"Unseen" or reported costs also result from an inability to measure or describe certain impacts. In particular the vocabulary currently used to describe climatological impacts

[20] Hewitt, *Calamity in a Technocratic Age*, Interpretations of Calamity, Ed. K. Hewitt, Allen & Unwin Inc., Boston, c1983, p25.
[21] National Research Council, Nature's Numbers: Expanding the National Economic Accounts to Include the Environment, National Academy Press, Washington, D.C., c1999.
[22] National Research Council, The Impacts of Natural Disasters: A Framework for Loss Estimation, National Academy Press, Washington, D.C., c1999, p35.
[23] Clarke, C., Munasinghe, M., *Economic Aspects of Disasters and Sustainable Development: An Introduction*, Disaster Prevention For Sustainable Development: Economic and Policy Issues, Ed. Munasinghe, M., Clarke, C., IDNDR, World Bank, c1995.

chiefly focuses upon monetary worth as well as the loss of life. Perhaps the condition of life (injured or displaced) is also recorded. These few indicators, however, are not enough to capture many of the losses experienced in underdeveloped regions, nor are they capable of describing the loss of items that do not hold a global market value. For instance the loss of a shanty house or small wooden bridge is indeed a loss although it would be difficult to place it in many impact data series. ***As a possible remedy this report suggests that the future emphasis of impact records be placed upon functionality (or non-market utility) rather than market or resource value.***

For example the monetary value of a large frame house is certainly greater than its earthen or thatched counterpart in a remote region. Functionally, however, the structures both serve the same purpose of providing shelter for a household, therefore the gross utility of each structure is equal. In dollar value, however, production of a frame house consumes more resources and therefore possesses greater monetary worth. The same could be said for any type of infrastructure. A gravel road in a remote area perhaps has the same ***local utility*** as a paved road in a developed area.

f. Sources

In addition to the biases inherent to certain estimators, the sources and methods used to gather information often superimpose additional prejudices on these measures. For instance monetary losses, as measured by the insurance industry, are likely to be very different from that of a government and certainly different from a humanitarian agency. Each source of information will inevitably express what it views as important (usually as its own exposure or loss) through the data it collects. Such biases manifest as regional preferences as well as target specific populations. This is not to say any one method is wrong or better, rather each source simply describes only a small part of the whole.

In example many insurance companies typically describe climatological losses through claims. As a result only a select portion of the population (that which can and does obtain insurance) is reflected in the totals. On a global scale, insurance companies are much more active in developed nations and areas where cultural practices favor the concept of insurance, therefore resolution and quality of impact information in underdeveloped regions of the globe is poor if simply non-existent. Burton et al have previously noted that biases exist "toward overestimating losses from industrialized countries and underestimating losses in developing countries or in areas remote from centers of government and mass media."[24]

Moreover, sources are bound to interpret the definition of an estimator differently. For instance does the measure of "dollar loss" reflect wealth, actual structural losses, lost productivity, or simply all changes that can be described through monetary value? Is there any attempt to differentiate the coincidental losses from those actually attributable to a climatological event? "Persons affected" is a common measure of impact, but rarely is it clearly defined to include or exclude certain populations.

[24] Burton, Kates, White, The Environment as Hazard, second edition, The Guilford Press, New York, c1993.

Needless to say, the situation of people affected by a power outage for three hours is not comparable to those with flooded property. Many indicators unfortunately blur inconvenience and hardship.

Finally, because sources of impact data are for the most part limited to governments, insurance companies, and humanitarian groups, most records reflect climatological disasters. Admittedly disasters are perhaps where the most immediate advances and savings might occur, but a larger, still unmeasured frontier exists in documenting indirect costs, higher order affects on development, and particularly ecological losses.

g. Gains

On a grander scale humans have done well to adjust to the expected seasons (whether it is the monsoon, boreal spring, etc.) such that we are sheltered from most of the harsh extremes while exploiting conditions favorable for agriculture, energy production, etc. In similar fashion the "seasons" affiliated with inter-annual and decadal variability likely provide opportunities in addition to the already recognized hazards. For instance above normal rainfall can often result in multiple cropping seasons in various regions of the globe.[25]

Unfortunately few case studies, and even fewer inventories, of climatological benefit and opportunity have been attempted. In part this is because the "positives" of climate must be further defined and categorized. As noted earlier within this report, the non-catastrophic impacts associated with climate variability are not routinely measured, and therefore the higher order effects on development and the "daily rent" of climate is not well documented.[26] In much the same way, the benefits associated with climate variability are not documented in regards to development and resource scarcity. Needless to say if we can not thoroughly record and identify the losses incurred by climate variability, it is difficult, if not impossible, to note when these losses do not occur or when other benefits are present.

While identifying the benefits associated with climate variability, it is equally important to differentiate between societal benefits (as in lower regional energy expenditures during a warmer winter) and benefits obtained by a few individuals (as in an increased demand for a particular commodity or service). At the same time benefits must also be differentiated by those who use climate information to optimize production[27] versus those whose benefits are fortuitous. As climate forecasts, observations, and other information improve, several equity issues will arise as to who is better enabled to avoid disaster as well as who possesses the resources to better capitalize upon opportunities.

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[25] Asian Disaster Preparedness Center (ADPC), La Niña 1998-99 Challenges and Opportunities for Indonesia, draft, September 1998.
[26] National Research Council, Making Climate Forecasts Matter, Stern, P., Easterling, W., editors, National Academy Press, Washington, D.C., c1999, p97.
[27] Pfaff, A., Broad, K., Glantz, M., "Who Benefits from Climate Forecasts?", *Nature*, VOL397, Feb. 25 1999.

Excerpt from K. Sponberg, Compendium of Climatological Impacts: Vol. 1, August 1999.

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